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Title: Iron Corrosion Observations: Pu(VI)-Fe Reduction Studies

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Iron Corrosion Observations: Pu(VI)-Fe Reduction Studies

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Experimental Matrix for LANL/ACRSP Pu Reduction Studies

- Pu-242 used
- GWB and ERDA-6 brines
- Fe coupon, Fe powder, and Fe oxides

Table 2. Experimental Matrix for the Pu-Fe Interaction Study

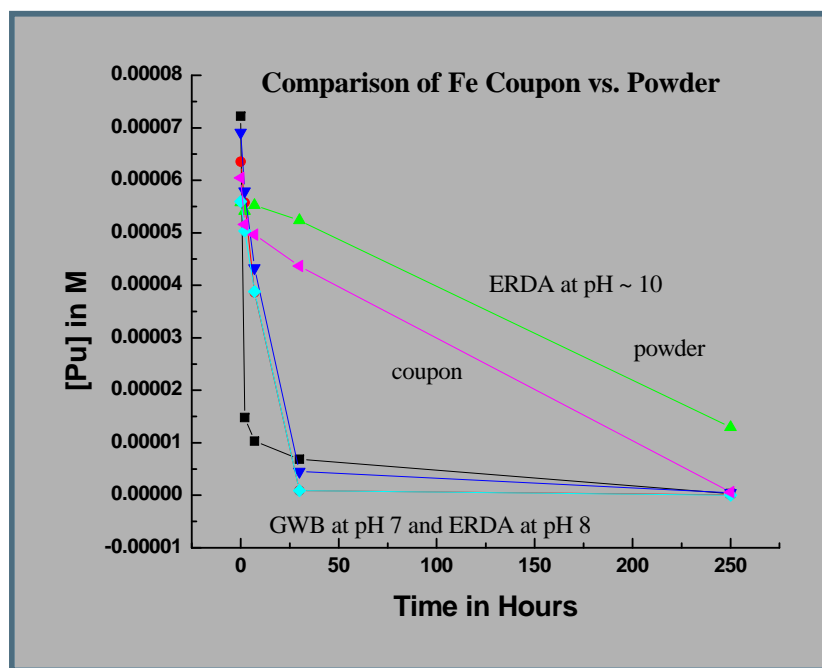
Experiment Designation (1,2)	Iron Content	pH	Duration (3)	Brine	Environmental Conditions
Experiments to reproduce Xia et al.					
Pu-FEP-N8-1, 2	Fe Powder	8	4 wks	0.01 M NaCl	Room T, 15 mL, anoxic, without carbonate
Pu-FEP-N10-1, 2	Fe Powder	10	4 wks	0.01 M NaCl	Room T, 15 mL, anoxic, without carbonate
Pu-FEP-E8-1, 2	Fe Powder	8	4 wks	ERDA-6	Room T, 15 mL, anoxic, without carbonate
Pu-FEP-E10-1, 2	Fe Powder	10	4 wks	ERDA-6	Room T, 15 mL, anoxic, without carbonate
Pu-FEP-GWB7-1,2	Fe Powder	7	4 wks	GWB	Room T, 15 mL, anoxic, without carbonate
Experiments to reproduce Reed et al.					
Pu-FEC-E8-1, 2	Coupon	8	4 wks	ERDA-6	Room T, 15 mL, anoxic, with carbonate
Pu-FEC-E10-1, 2	Coupon	10	4 wks	ERDA-6	Room T, 15 mL, anoxic, with carbonate
Pu-FEC-G7-1,2	Coupon	7	4 wks	GWB	Room T, 15 mL, anoxic, without carbonate
Experiments to investigate Fe oxidation state Dependence					
Pu-FEC-1, 2	Fe Coupon	9	4 wks	5.0 M NaCl	Room T, 15 mL, anoxic, with carbonate
Pu-FEP-1, 2	Fe Powder	9	4 wks	5.0 M NaCl	Room T, 15 mL, anoxic, with carbonate
Pu-FE2-1, 2	Fe ²⁺ Colloidal	9	4 wks	5.0 M NaCl	Room T, 15 mL, anoxic, with carbonate
Pu-FE3-1, 2	Fe ³⁺ Colloidal	9	4 wks	5.0 M NaCl	Room T, 15 mL, anoxic, with carbonate
Pu-FE3-OX-1, 2	Fe(III) oxide	9	4 wks	5.0 M NaCl	Room T, 15 mL, anoxic, with carbonate
Pu-FE23-OX-1, 2	Fe (II/III) oxide	9	4 wks	5.0 M NaCl	Room T, 15 mL, anoxic, with carbonate
Note (1) – Starting [Pu] = 0.1 mM, with an approximate Ci content of 1.4 µCi/experiment Note (2) – the notation 1,2 represents replicate experiments Note (3) – Experiments are 2 wks for Pu (VI) stability and 2 weeks following the addition of Fe					

Iron and Pu Reduction

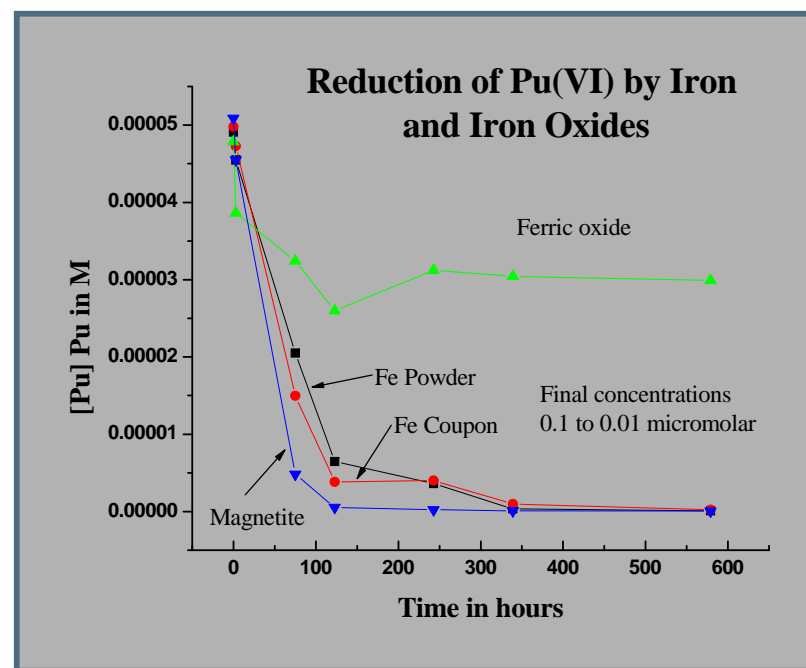
- Very different appearances in iron reaction products were noted depending on pH, brine and initial iron phase
- Plutonium was associated with the Fe phases
- Green rust was often noted at the higher pH
- XANES established the green rust to be an $\text{Fe}_2/3$ phase with a bromide center
- This green rust phase was linked to Pu as Pu(IV)



Reduction of Pu(VI) by Zero Valent Iron



Pu(VI) reduction by Fe (coupon and powder)



Pu(VI) reduction by Iron Oxides (Mixed valent)

Weight Loss in Fe Coupons

- ~ 6 year data, appearance after cleaning is metallic (silver) with rough morphology
- Surface area is ~ 1.5 cm²
- Corrosion products analyzed by XRD for lower pH data set are primarily oxy-hydroxides with possibly some pure hydroxides and Ca-Fe minerals
- Green rust observed at pH >9 – Br- substituted based on elemental analysis at the APS

Fe Weight Loss
Pu-Fe Interaction Studies

